6. Cooperative Programs

Evaluation of Arctic Meteorological Buoys

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INTRODUCTION

The United States Interagency Arctic Buoy Program (USIABP) was formed in 1991 to establish and maintain a network of drifting meteorological buoys in the Arctic. The USIABP is a collaborative program funded by nine government agencies/ programs and managed by the National Ice Center in Suitland, Maryland. The USIABP supports the International Arctic Buoy Program (IABP) which consists of numerous countries participating in the collection of meteorological data from Arctic drifting buoys.

The buoys are located to define surface synoptic scale atmospheric pressure, air temperature, and sea-ice drift fields. The data are available in real time, via ARGOS satellite transmissions, to operational weather forecasting centers as well as research into climate change. At the inception of the program, 25 buoys gathered temperature and pressure data in the Arctic with 72% reported on the Global Tele-communications System (GTS). In early 1994, 47 buoys were in operation with 96% reported on the GTS.

There are many different buoys used by the IABP with different sensors, configurations and sampling schemes. Many of the temperature measurements reported by the buoys were suspect when compared to atmospheric model predictions. In 1993 it was decided by the USIABP to halt deployment of new buoys until the sources of temperature measurement errors were investigated. A program was established to evaluate the available "off-the-shelf" Arctic buoy systems being used by the IABP. As part of this evaluation, a long-term test site was established at the CMDL facility in Barrow, Alaska.

THE FIELD TEST SITE

In August 1993, a Coastal Climate buoy and a DSI-TAD buoy were placed at the Barrow facility. A data acquisition system was placed at the site consisting of a Telonics ARGOS uplink receiver and a Compaq notebook computer. Buoy transmissions are received and logged on the computer. Weekly interrogations of the computer are performed from Silver Spring, Maryland, and data files are downloaded. In December 1993, a Canadian MetOcean CALIB buoy was added to the array, and in March 1994 a Norwegian ICEX buoy was placed at the site.

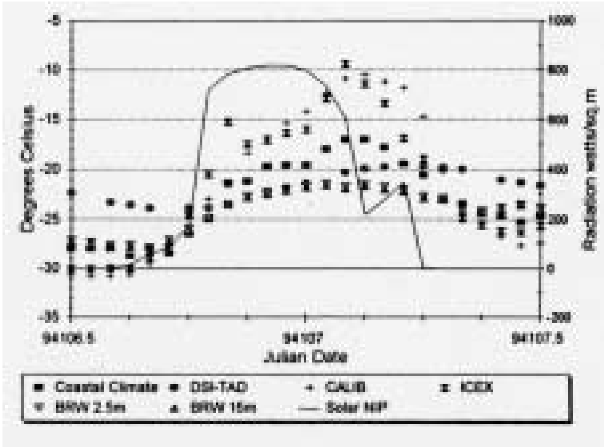
DATA ACQUISITION AND ANALYSIS

All buoys in the test program undergo temperature sensor calibration at the National Weather Service Test Facility in Sterling, Virginia, prior to shipment to Barrow.

Each buoy has its own measurement scheme, sampling interval, data format, and data transmission interval. Data collected in Silver Spring are processed and reduced into a standard 1-hr averaged data format. CMDL meteorological data are sent monthly for comparison with buoy data. Solar radiation data from CMDL is collected weekly via a recently established link to Internet.

Measurements are analyzed and compared to CMDL standards. Temperature differences between sensors and/or standards are analyzed to determine the effects of sensor height differences, solar radiation, and wind. Preliminary results indicate significant differences attributed to the measurement height of the sensors above the surface and to solar radiation effects.

CMDL measurements at BRW are on a tower located approximately 20 m from the buoy array. The CMDL temperature sensors are 2.5 m (BRW 2.5 m) and 15 m (BRW 15 m) above the ground. They are aspirated and kept clean of ice and snow by the staff at CMDL. Figure 1 shows temperature data from three buoys compared to the CMDL temperature standards during February 16-18, 1994. This period had winds below 5 m s^{-1} and insignificant solar radiation. The Coastal Climate buoy measures temperature at approximately the same height above the ground as the BRW 2.5-m sensor. The DSI-TAD buoy has an internal temperature sensor in a spherical hull approximately 1 m in diameter that sits on the surface. The CALIB buoy is a cylindrical buoy with an external temperature sensor that is measuring at a height of 1 m off the surface. The Coastal Climate buoy generally tracks the BRW 2.5 m sensor to within 1°C. The DSI-TAD buoy shows a strong time lag to the falling temperatures because of its internal sensor. The CALIB sensor shows lower temperatures at times when there is a vertical temperature



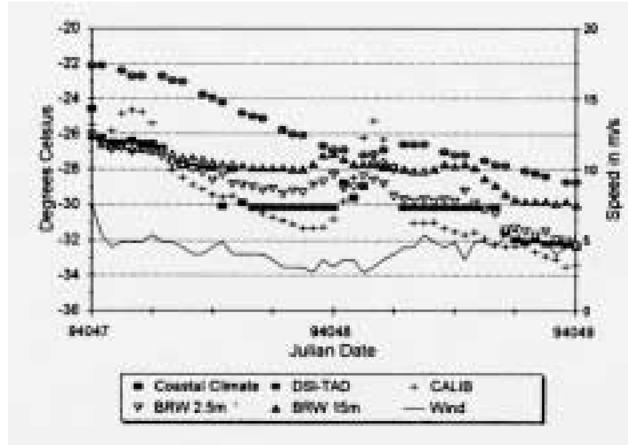


Fig. 1. Hourly-averaged temperature measurements for three buoys and the BRW standards. The BRW sensors are identified by their height, BRW 2.5 m is the sensor at 2.5 m above the ground, BRW 15 m is 15 m above the ground

Fig. 2. Hourly-averaged temperature readings for four buoys and the BRW standards. Direct solar radiation is shown by measurements from the Normal Incidence Pyrgeometer (NIP). The effects of solar heating are depicted.

gradient indicated by the BRW 2.5 m and BRW 15 m sensors, showing the gradient continues to ground level.

Figure 2 shows a 24-hr period on April 17, 1994. This period shows a typical day of strong solar radiation with low temperatures and light winds. The aspirated BRW sensors show no vertical temperature gradients. The additional ICEX buoy is a spherical type buoy that sits on the surface and has an external temperature sensor at approximately 1 m above the ground. All sensors have some form of radiation shielding. The ICEX and the CALIB buoys show strong effects from solar heating while the Coastal Climate buoy does not due to a larger radiation shield. The DSI-TAD shows moderate effects with long response times.

FUTURE PLANS

It is planned to introduce one more buoy to the site in August 1994. We will also place a 3-m Rohn tower with aspirated temperature sensors at the 1-m and 2.5-m level, a solar radiation sensor, and an anemometer. These sensors will complement information on the vertical and horizontal spatial effects of the temperature field when compared to the CMDL Barrow standards. The tower will be located in the buoy array area. The site will remain until sufficient long-term data has been acquired to assess the performance of each buoy.